

इंटरनेट

मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”

Mazdoor Kisan Shakti Sangathan

“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 11793 (1986): Guidelines for design of float-driven hoisting mechanism for automatic gated control [WRD 12: Hydraulic Gates and Valves]



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE



Indian Standard

GUIDELINES FOR
DESIGN OF FLOAT DRIVEN HOISTING
MECHANISM FOR AUTOMATIC GATED
CONTROL

UDC 627.833.61.04



© Copyright 1987

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

GUIDELINES FOR DESIGN OF FLOAT DRIVEN HOISTING MECHANISM FOR AUTOMATIC GATED CONTROL

Hydraulic Gates and Valves Sectional Committee, BDC 56

Chairman

SHRI Y. ADINARAYANA SASTRI
26 Park Area, Karol Bagh, New Delhi

Members

SHRI D. S. AHUJA

SHRI BALWANT SINGH (*Alternate*)

SHRI G. S. ANNIGERI

SHRI DHARMINDER CHARAN

CHIEF ENGINEER

DIRECTOR (M & E) (*Alternate*)

SHRI R. C. CHOPRA

SHRI R. BHATTACHARYA (*Alternate*)

SHRI H. C. DHINGRA

SHRI R. S. CHAUHAN (*Alternate*)

DIRECTOR

SHRI A. V. GOPALAKRISHNA (*Alternate*)

DIRECTOR (GATES & DESIGNS I)

SHRI C. L. VERMA (*Alternate*)

SHRI K. K. JULKA

SHRI V. P. KAUSHAL (*Alternate*)

SHRI K. V. S. MURTHY

SHRI M. K. V. SARMA (*Alternate*)

SHRI RAJ KUMAR

SHRI N. Y. NARASIMHAN (*Alternate*)

SHRI P. RAMAKRISHNAN

SHRI P. ARUNACHALAM (*Alternate*)

Representing

Nangal Workshops, Irrigation Department,
Government of Punjab, Nangal Township

Tungbhadra Steel Products Ltd, P. O. Tungbhadra
Dam

Irrigation Department, Government of Uttar
Pradesh, Lucknow

Irrigation Works, Government of Punjab,
Chandigarh

Texmaco Ltd, Calcutta

Haryana State Minor Irrigations (Tubewells)
Corporation Ltd, Chandigarh

Central Water & Power Research Station, Pune

Central Water Commission, New Delhi

Beas Project, Talwara BBMB, Chandigarh

Triveni Structurals Ltd, Naini

Bharat Heavy Electricals Ltd, Hyderabad

Public Works Department, Government of
Tamil Nadu, Madras

(Continued on page 2)

Copyright 1987

BUREAU OF INDIAN STANDARDS

This publication is protected under the *Indian Copyright Act* (XIV of 1957) and reproduction in whole or in part by any means except with written permission of the publisher shall be deemed to be an infringement of copyright under the said Act.

(Continued from page 1)

Members

SHRI S. K. SADHU
SHRI S. NAG (*Alternate*)
SUPERINTENDING ENGINEER CDO,
NASIK
SHRI R. SWARUP

SHRI K. C. BAHETY (*Alternate*)
SHRI M. C. TEWARI

SHRI N. VISWANATHAN

SHRI G. S. SHARMA (*Alternate*)
SHRI G. RAMAN,
Director (Civ Engg)

Representing

Jessop & Co Ltd, Calcutta

Irrigation & Power Department, Government of
Maharashtra, Nasik
Central India Machinery Manufacturing Co Ltd,
Bharatpur (Rajasthan)

Himachal Pradesh State Electricity Board, Govern-
ment of Himachal Pradesh
National Hydro-Electric Power Corporation, New
Delhi

Director General, ISI (*Ex-officio Member*)

Secretary

SHRI HEMANT KUMAR
Deputy Director (Civ Engg), ISI

Indian Standard

GUIDELINES FOR DESIGN OF FLOAT DRIVEN HOISTING MECHANISM FOR AUTOMATIC GATED CONTROL

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 June 1986, after the draft finalized by the Hydraulic Gates and Valves Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Hoisting mechanism of gated-control may be driven by a 'float' instead of an electric motor. The float possesses twin self-opposing forces of gravity and bouyancy, one due to its weight and the other due to its submergence in water in a float-well. It may be considered as a hydraulic counterweight. With no submergence, full weight of the float acts as a counterweight to operate the gate in one direction. With submergence, upthrust exerted by bouyancy decreases the effective weight of this counterweight (float). With increase in submergence, the counterweight effect of the float is decreased to the extent that the gate gets operated in the opposite direction. When gravity and bouyancy are balanced, the gate stops in its position and gated opening does not change. Thus operation of the gate is effected by adjusting the water-level in the float-well. It is done by admitting water to or draining water from the float-well through suitable flow-control devices such as weirs, orifices or valves. By making operation of these flow-control devices automatic, the gated-control is made automatic.

0.3 An automatic mechanism is a self regulating arrangement to keep the controlled-variable in a balanced equilibrium state within certain predetermined-limits without involving any external manual intervention. It comprises of the following main components:

- a) *Regulator* — It provides control-action to regulate variations in the controlled-variable.
- b) *Operator* — It provides control-power to operate the regulator.
- c) *Sensor* — It provides control-selection. It detects the difference between actual and predetermined-limits, that is the deviation of the

controlled-variable from its predetermined-limits of the balanced state of equilibrium, and selects control to operate the regulator to restore the lost balance by bringing the controlled variable nearer possible to its predetermined limits.

0.4 In case of an automatic gated-control, the regulator is the gate, the operator is the float-driven hoisting-mechanism and the sensor is the flow-control device admitting water to or draining water from the float-well in response to deviation of the controlled-variables from its predetermined-limits of balanced equilibrium state.

0.5 In case water-level in a hydro-electric channel is to be kept constant within the predetermined-limits, water-level responsive sensors may be a control-weir and a pilot float operated drain valve. When water-level rises in the channel, water is admitted to the float-well through the control-weir to open the gate and thereby lowering the water-level in the channel to its predetermined-limit. When water level falls in the channel, water is drained from the float-well through a pilot-float operated drain valve to close the gate and thereby raising the water-level in the channel to its predetermined-limit. With water-level in the channel within the predetermined-limits, neither inflow to nor outflow from the float-well takes place and gated-opening remains constant.

0.6 In case it is desired to close a forebay gate automatically in a power channel feeding a hydro-electric power house when a sudden load-tripping takes place and hydraulic turbines are endangered by run-away speed, the sensor may be a solenoid-valve which opens by an electric-signal responsive to load-tripping or run-away speed of the hydraulic turbine and drains water from the float well to close the gate. To obtain quicker gate closure, the solenoid-valve may be used as a pilot to open a larger float-operated drain valve to drain water from the float-well at a higher rate.

0.7 Sometims an additional-drive such as an electric-motor may also be provided to operate the gate when float-drive is under maintenance or out of order or otherwise fails to meet any emergent requirements. Normally, the additional-drive is kept declutched or unoperative and gated-control is done by float-drive only. However, when the additional drive is brought into operation, the gated-control may entirely be done by the additional-drive alone or may be done together with the float-drive by suitable arrangements of the hoisting mechanism as shown in Fig. 4.

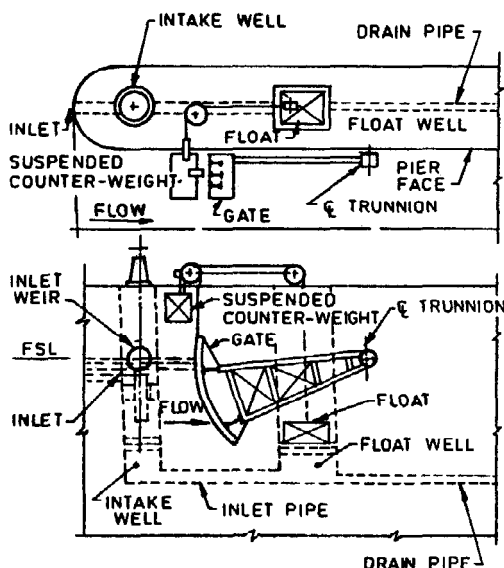
0.8 The description given in 0.2 to 0.7, the float-driven hoisting-mechanism for the automatic gated-control, is adaptable for a wide range of applications with wide range of arrangements due to a variety of types of gates and a variety of hoisting-mechanisms, as also a variety of a automatic flow-control devices (sensors) which admit water to or drain water from the float-well. However, float-well has its limitations also due to practicable

size of the float-well and in general, its hoisting effort may be limited to 20 tonnes unless float-well for larger size of float is conveniently practicable on the given project.

1. SCOPE

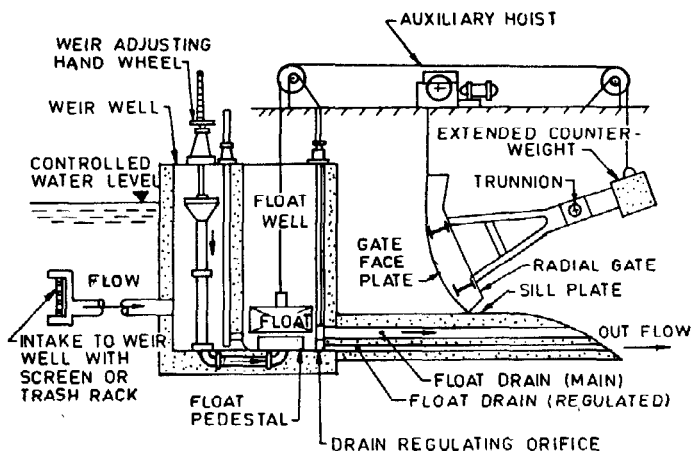
1.1 This standard lays down guidelines for design of a float-driven hoisting-mechanism for automatic gated-control.

1.2 This standard includes only typical arrangements commonly used, since possible arrangements are numerous due to a variety of types of gates, hoisting-mechanisms, float-drives and automatic flow-control devices (sensors). This may be used to admit water to or drain water from the, float-well in response to deviation of the controlled-variable from its predetermined-limits. Design guidelines are therefore limited accordingly (see Fig. 1 to 11).



NOTE — In the arrangements shown, float is moving up, gated-opening increases suitable to control water surface at U/S side of the gate.

FIG. 1 TYPICAL ARRANGEMENT FOR FLOAT DRIVEN HOISTING MECHANISM FOR AUTOMATIC GATED CONTROL



NOTE 1 — In the arrangements shown, float is moving up, gated-opening increases suitable to control water surface at U/S side of the gate.

NOTE 2 — Float drain has been shown as controlled by an orifice for better sensitivity and stability of operation. Automatic drain valves may be provided.

FIG. 2 TYPICAL ARRANGEMENT FOR FLOAT DRIVEN HOISTING MECHANISM (WITH COUNTERWEIGHT SUPPORTED ON EXTENDED PART OF GATE ARM) FOR AUTOMATIC GATED CONTROL

1.3 This standard includes typical arrangements to keep water-level constant in a hydro-electric and other locations channel at the upstream or downstream side of the gate.

1.4 This standard includes typical arrangement for emergency closure of a power channel feeding a hydro-electric power-house, to prevent damage to the hydraulic turbine and generators by run-away speed conditions when sudden load-tripping takes place at the power house.

1.5 This standard does not include the structural design of the gate, the hoisting-mechanism and the other components, for which relevant Indian Standards may be referred to. However, outlines of the structural arrangements of certain components, where considered necessary in the interest of functional reliability, are included.

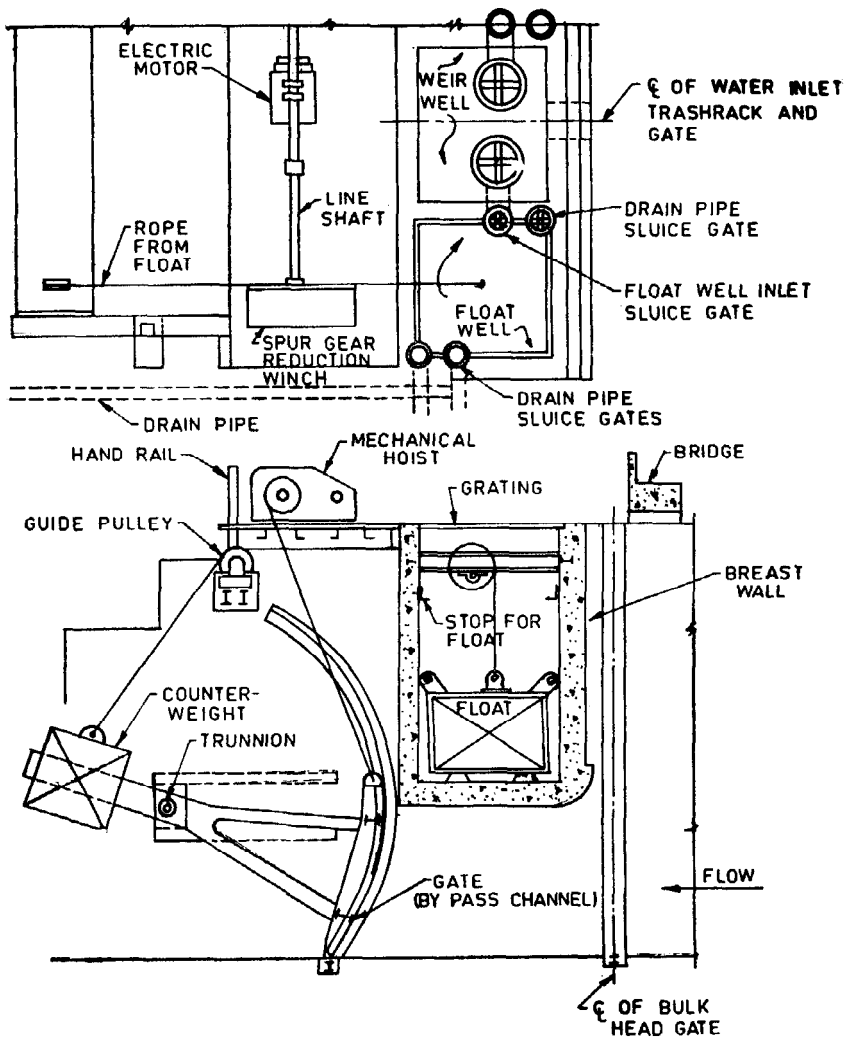
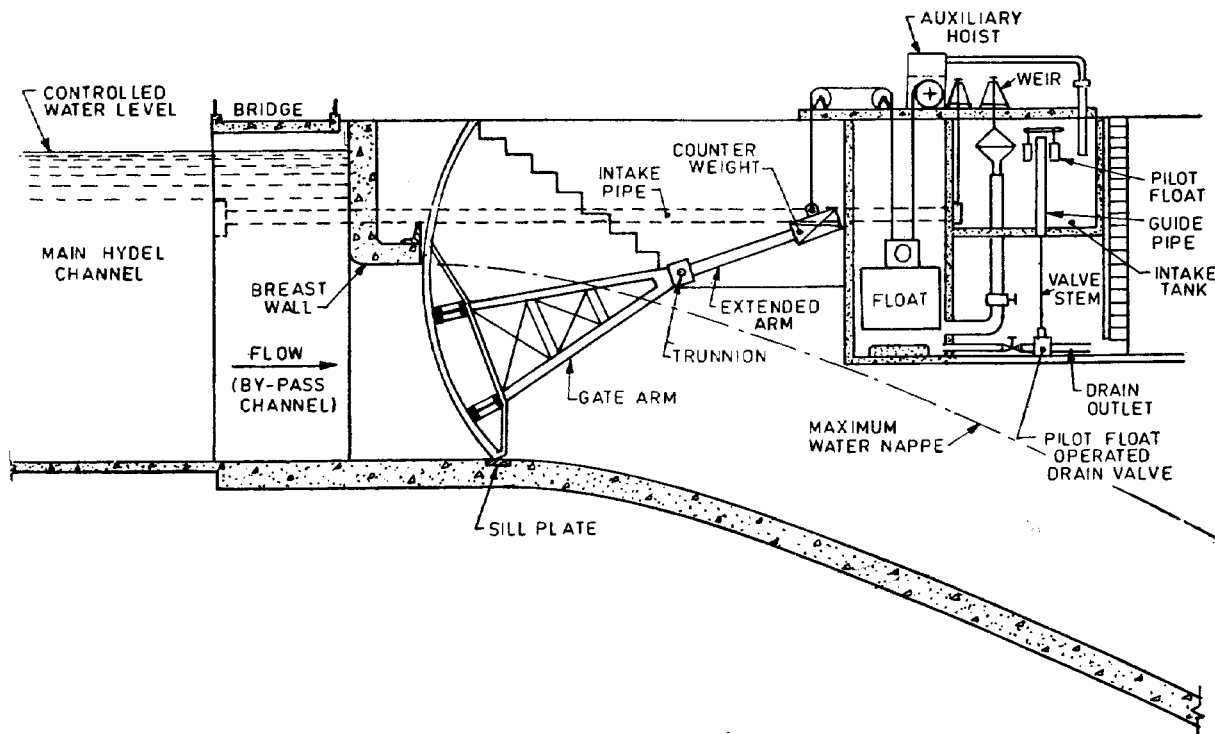


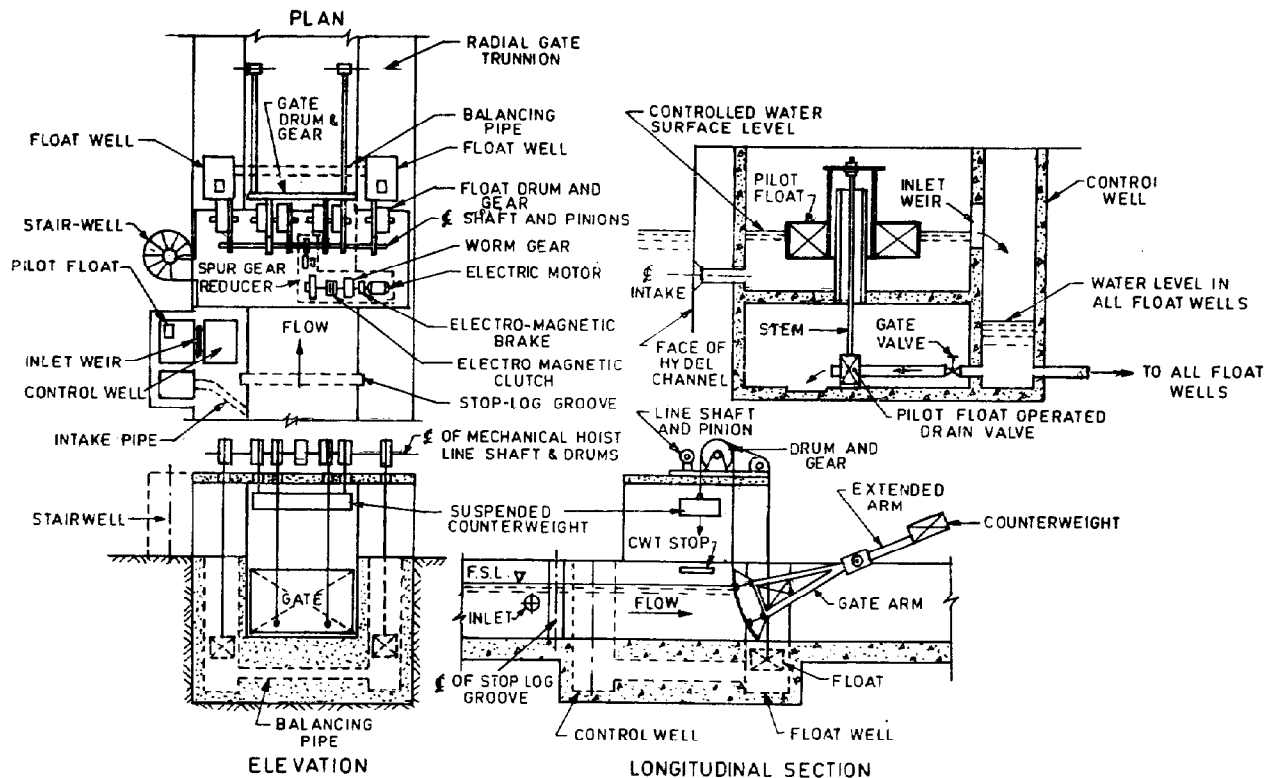
FIG. 3 FLOAT DRIVEN HOISTING MECHANISM FOR AUTOMATIC GATED CONTROL OF FLOW THROUGH BY PASS CHANNEL

8



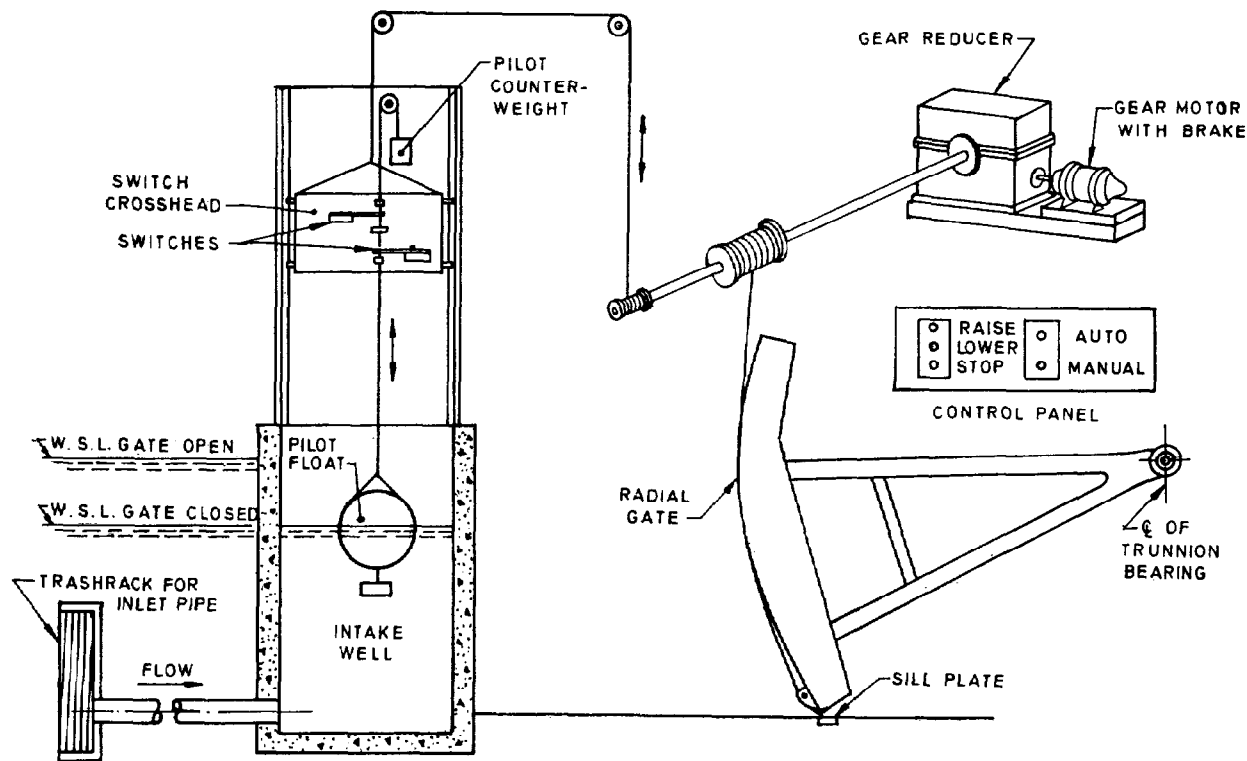
NOTE — The arrangement shown above is same as that for Fig. 2 except that pilot float operated drain valve has been provided for automatic control of outflow from float-well. Also auxiliary hoist is shown connected to the counterweight through a pulley on the float instead of connecting to gate as shown in Fig. 2. This arrangement of auxiliary hoist allows it to function together with float without requiring clutch and can raise the gate or lower the gate as required. For its automatic operation, water level sensing contacts (no-float electrodes or pilot-float operated switches) may be installed in the intake-well but the setting may be kept beyond the limits set for float-drive so that normal operation is done by float-drive only.

FIG. 4 SCHEMATIC DIAGRAM OF FLOAT-DRIVEN HOISTING MECHANISM FOR AUTOMATIC GATED CONTROL



NOTE — Hydraulic function is same as Fig. 3.

FIG. 5 FLOAT-DRIVEN HOISTING MECHANISM FOR AUTOMATIC GATED CONTROL PROVIDED ACROSS THE MAIN HYDEL CHANNEL



NOTE — Instead of pilot-float controlled switches, non-float type switches may be provided for automatic gated control by auxiliary hoist.

FIG. 6 SCHEMATIC DIAGRAM OF PILOT-FLOAT CONTROLLED ELECTRIC MOTOR DRIVEN AUTOMATIC GATED CONTROL

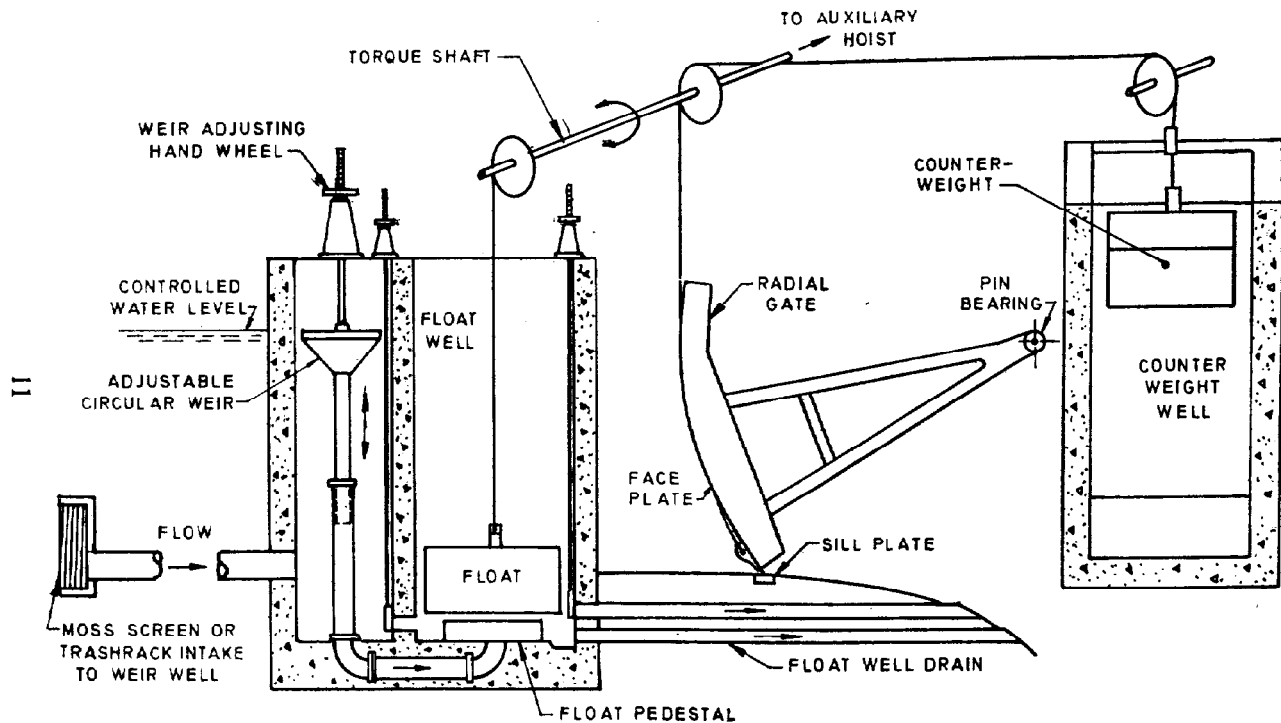


FIG. 7 SCHEMATIC DIAGRAM OF AUTOMATIC FLOAT OPERATED RADIAL GATE (TORQUE TYPE)

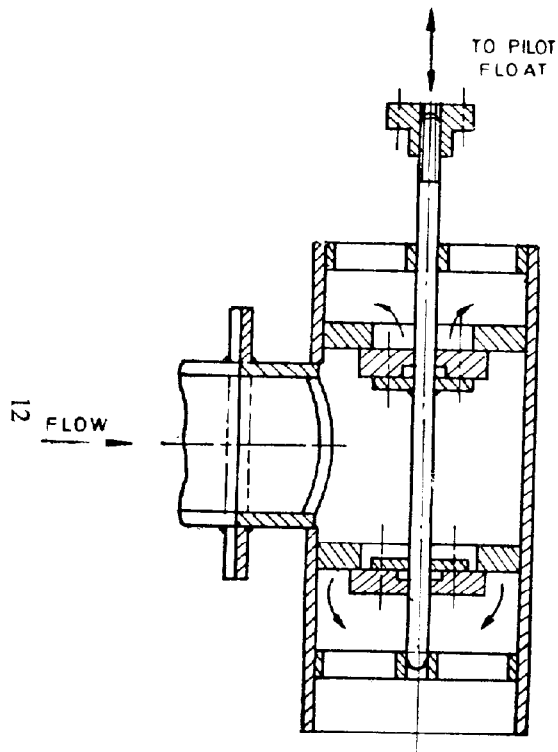


FIG. 8 DOUBLE SEAT BALANCED TYPE
DRAIN VALVE (OUTFLOW AT TOP
AND BOTTOM)

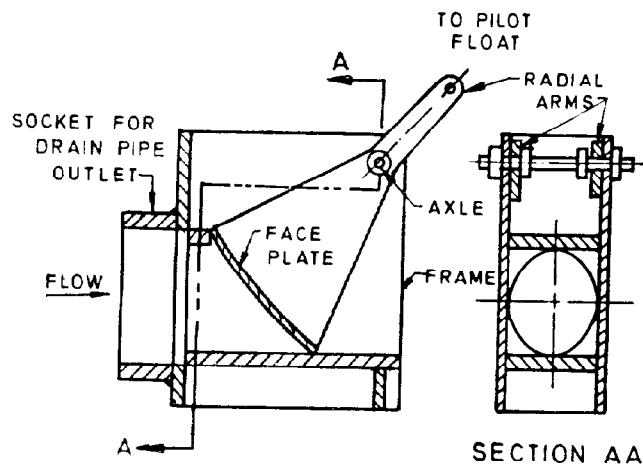


FIG. 9 RADIAL TYPE DRAIN VALVE (OUTFLOW
HORIZONTAL)

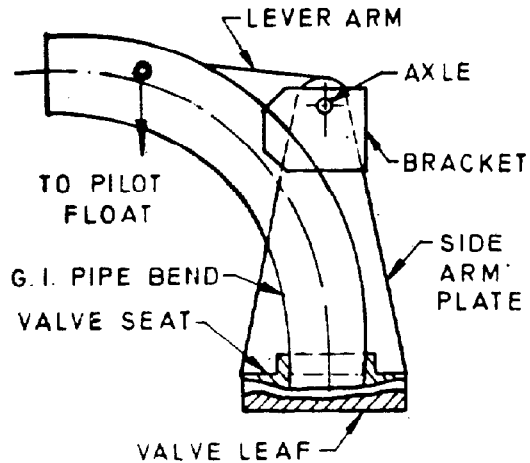


FIG. 10 RADIAL TYPE DRAIN VALVE (OUTFLOW VERTICAL)

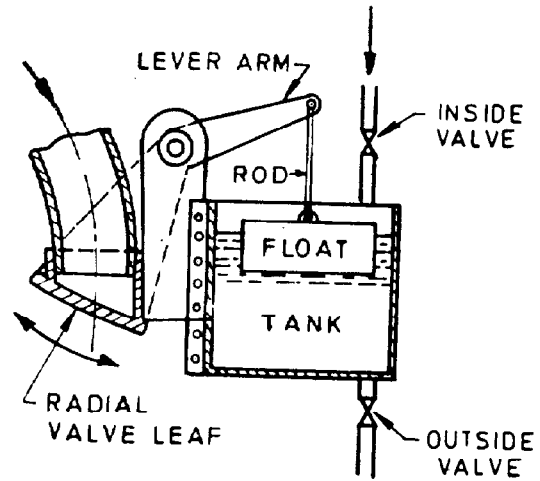


FIG. 11 RADIAL TYPE DRAIN VALVE (OUTFLOW AT AN ANGLE)

2. MAIN COMPONENTS

2.1 A typical arrangement of float-driven hoisting mechanism for automatic gated-control may comprise of the following components:

- a) Gate,
- b) Counterweight,
- c) Float,
- d) Float-well and control-piping,
- e) Control-well and common-header,
- f) Intake-tank and feed pipe/channel,
- g) Flow-control/sensors,
- h) Float-driven hoisting-mechanism, and
- j) Additional electric-drive.

2.2 Gate

2.2.1 Type of gate may be selected to make best use of the limited hoisting effort available from a float-driven mechanism and also to ensure good reliability of the automatic-operation. The following factors shall be considered:

- a) Minimum frictional resistance during operation to minimize the hoisting effort requirement;
- b) Minimum chances of jamming;
- c) Minimum variation in its effective weight due to uplift, downpull, bouyancy and silt deposit on its horizontal surfaces during operation or submergence;
- d) Simplicity in construction and easy accessibility; and
- e) Good hydraulic performance at partial gate opening.

2.2.2 A radial gate satisfies the considerations outlined in **2.2.1** to a sufficient extent and may, therefore, be preferred for an automatic gated-control by float driven hoisting-mechanism.

2.2.3 Gate of any other type may be provided where it is preferred due to other factors. Thus a vertical lift gate may be provided where available pier length is shorter than that required for a radial gate due to its long arms and deep anchorage. A fish belly type gate may be preferred, where

excessive floating debris is to be passed above the top of the gate. However, in such cases, it may be kept in view that vertical lift gate of slide type has excessive frictional resistance, vertical lift gate of fixed wheel type has greater chances of jamming of its wheel-bearings, and the bearings of a fish belly gate remain submerged and are not easily accessible. Such factors necessitate hoisting effort requirement of greater value than that for a radial gate and therefore the size of float and float-well may be suitably increased to have sufficient reserve capacity to overcome the additional worst possible conditions during the automatic gated-operation.

2.3 Counterweight

2.3.1 The various types of counterweight provided for gated-control are:

- a) *Balancing Counterweight* — It is provided to balance the effective weight of the gate to the extent that the counterweight gate remains self-closing type. Its provision reduces the hoisting effect requirement and therefore decreases the size of the float and the float-well.
- b) *Hoisting Counterweight* — It is provided to overcome the effective weight of the gate completely and to make the counterweighted gate self-opening type. In this case, weight of the float lifts the hoisting counterweight instead of the gate so that with float going down, the hoisting counterweight goes up and the gate goes down. In other words, the gate goes down as float goes down and gate goes up as the float goes up.
- c) *Extended Counterweight* — It is provided in case of radial gate with extended portion of gate arms beyond trunnion centre in such a way that it does not obstruct the flow for any gate opening to support the counterweight. Its effect is determined by the principle of levers with fulcrum considered at trunnion centre.
- d) *Suspended Counterweight* — It is kept suspended and is connected to the gate or the float through a rope or a chain.

2.3.2 Counterweight may generally be of a steel frame or box containing slabs of cast iron or concrete or any other high density filling material. Suitable provision shall be made to vary the weight of the counterweight for field adjustments to meet the actual requirements.

2.4 Float

2.4.1 As given in 0.2, the float is a hydraulic counterweight possessing twin self-opposing forces of gravity due to its weight and buoyancy due to the upthrust by its submergence in water in a float-well. After its full submergency, its buoyancy is more than its gravity and it floats when left to

itself. In case its bouyancy remains less than its gravity even after full submergence, it does not float when left to itself and such a hydraulic counterweight may be called a displacer instead of a float.

2.4.2 Weight of the float (or displacer) may be so provided that under no submergence, it serves as a counterweight to operate the gate in one direction (open or close) according to the hoisting arrangement provided. Volume of the float (or displacer) may be so provided that under its 90 percent submergence, its upthrust (bouyancy) reduces the effective weight of the counterweight (float or displacer) to the extent that gate gets operated in the opposite direction (closes or opens respectively).

2.4.3 Generally, float may be made of a hollow leak-proof steel box with its surfaces protected by water resistant paint conforming to relevant Indian Standards. As the float is a very critical item in the automatic functioning of the gate, design of float shall be such that it is leak-proof to ensure its intended functioning.

2.4.4 If provided with a removable top cover, joints between the top cover and the hollow box may be made water-tight so that water does not enter the hollow space in case of full submergence.

2.4.5 Provision may be made to change its weight to suit the actual operational requirements in the field.

2.4.6 Guide rollers may be provided at all the four top edges of the float or on the float-cover to facilitate easy movement of the float in the float-well.

2.5 Float-Well and Control Piping

2.5.1 The float shall be installed in the float-well. Area of the float-well may correspond to the area of the float with a little clearance all around to facilitate easy movement of the float in it. Depth of the float-well may be so designed that the top of the float-well shall be above the maximum water level to be controlled and its bottom remains clear of the bottom of the float in its lowermost position to the extent that the silt deposit and direct flow from the control pipe may not interfere with the float travel such that there is effective water pressure at the bottom to ensure floating action.

2.5.2 Quantity of water to be changed in the float-well for gate operation by the float-drive may be determined as:

$$Q_f = A_f \times S_f$$

where

Q_f -- Quantity of water to be changed in the float-well,

A_f = Area of the float-well, and

S_f = Travel of the float.

Generally, gate is operated at a speed of 0.3 to 0.6 metre/minute so that Q_f may vary from 300 to 600 litres/minute for every square metre area of the float-well when speed of float is the same as that of the gate. Depending on the hoisting arrangement, the speed of float may differ from the speed of the gate and Q_f is varied accordingly.

2.5.3 Size of control-piping at inlet to and outlet from the float-well may be determined to suit Q_f using principles of hydraulics.

Thus $Q_i = Q_f + Q_o$ for increase of water level in the float-well,

and $Q_o = Q_f + Q_i$ for decrease of water level in the float-well.

where

Q_i = Flow through control-piping at the inlet to the float-well, and

Q_o = Flow through control-piping at the outlet of the float-well.

Where Q_i and Q_o do not take place simultaneously, the arrangement becomes more sensitive, since Q_i and Q_o are not required to exceed Q_f as required in the case under simultaneous flow conditions.

2.5.4 Opening for inlet and outlet from the float-well may be located a little above the bottom of the float-well to account for any silt-deposit but these may be located a little below the bottom of the float in its lowermost position, to prevent interference of float travel with direct flow through control-piping. Additional dewatering pipe may be provided at the bottom of the float-well to enable complete dewatering of the float-well to facilitate silt-clearance.

2.5.5 Location of the float-well may be so selected that a deeper float-well may be made, keeping its drain outlet level above the maximum level of the available drain to prevent backflow of water from the drain to the float-well. Lesser the value of Q_f , quicker is the float-travel for the same flow through the control-piping or, in other words lesser is the flow required through the control-piping for the same float-travel.

2.5.6 Top of float-well may be provided with removable cover so that any unwanted object may not fall into it which may interfere with the float-travel.

2.6 Control-Well and Common-Header

2.6.1 In case, a number of gates are operated simultaneously by float-drives, all the float-wells may be connected to control-well through a common-header so that water admitted to or drained from the control-well changes water-level in all the connected float-wells simultaneously.

2.6.2 The quantity of water to be admitted to or drained from the control-well through the flow-control-sensors provided for it, may be determined by the combined requirement of all the float-wells connected to it.

2.6.3 Shut-off valves may be provided between the common-header and the float-wells to enable isolation of any float-well, when required, for maintenance/silt-clearance.

2.7 Intake-Tank and Feed Pipe/Channel

2.7.1 An intake-tank may be provided to serve as stilling well for installation of flow control sensors and a storage tank to feed water to the control-well through inlet-sensor.

2.7.2 The intake tank may be connected to a water source such as the hydro-electric channel (or reservoir) through a feed pipe/channel having grating at its inlet and to prevent entry of trash into it and also provided with a shut-off device for its closure to facilitate maintenance/silt-clearance.

2.7.3 A drain outlet may be provided at the bottom of the intake tank which may normally be kept closed by a shut-off valve and opened to facilitate silt-clearance.

2.8 Flow-Control-Sensors

2.8.1 Flow-control-sensors for inflow and outflow are provided for automatic control of water to be admitted to or drained from control-well.

2.8.2 The typical flow-control-sensors generally employed are:

- a) Crest-level controlled inlet-weir/orifice,
- b) Pilot-float operated drain valve, and
- c) Electric-signal controlled solenoid valve.

2.8.2.1 Crest-level controlled inlet-weir/orifice — An inlet-weir may be a rectangular opening in a vertical plane with its crest-level controlled by top edge of an adjustable plate mounted over a steel-frame fixed around the rectangular opening. An inlet-orifice may be a circular opening in a horizontal plane with its crest-level controlled by an adjustable telescopic piping having rubber seals at the telescopic surfaces. Either of these may be

installed in the intake tank with the crest-level adjusted to the predetermined-limit of water-level to be controlled in the hydro-electric channel (or reservoir) at upstream or downstream side of the gate as required, to which the intake tank feed pipe/channel inlet end is connected making water-level in the intake tank to correspond to the water level being controlled. Where water level in the intake tank rises above the crest level, water is admitted to the control well so that the float moves up. In case, the water level at upstream of the gate is to be controlled, the float moving up operates the hoisting-mechanism to increase gated-opening so that greater discharge through it begins to lower the controlled water-level towards the crest level of the inlet-weir/orifice. In case, the water level at downstream of the gate is to be controlled, the float moving up operates the hoisting-mechanism to decrease gate opening so that lesser discharge through it begins to lower the controlled water-level towards the crest-level of the inlet-weir/orifice. With water level in the intake tank at or below the crest level, water is not admitted to the control well so that the float no longer moves up. Under this condition, the float stops moving or begins moving down according to closure or opening of the drain sensor so that gated-opening keeps unchanged or operated in the reverse direction respectively.

2.8.2.2 Pilot-float operated drain valve — It is a drain sensor with the drain valve installed in out flow control piping and the pilot float installed in the intake tank. If water level in the intake tank is within or above the predetermined-limit, the pilot float keeps the drain valve closed. If water level in the intake tank is below the predetermined-limit, the pilot-float opens the drain valve and the float begins moving down. In case, the water level at the upstream of the gate is to be controlled, the float moving down operates the hoisting-mechanism to decrease gated opening so that lesser discharge through it begins to increase the controlled water level towards the predetermined-limit. In case, the water level at the downstream of the gate is to be controlled, the float moving down operates the hoisting-mechanism to increase gated-opening so that greater discharge through it begins to increase the controlled water level towards the predetermined-limit. In either case, the opening of the drain valve raises the controlled water level towards the predetermined-limit by suitable arrangement of the hoisting mechanism operating the gate.

2.8.2.3 Electric-signal controlled by solenoid valve — It is a valve operated by a solenoid which is energized by an electric current controlled by electric signals from a switching device. It may be provided for inlet sensor or drain sensor as per control function. Switching devices may be 'No flote' or static type electrodes or pilot-float operated switching contacts installed in the intake tank, with their operation so adjusted that the solenoid valves serving as inlet sensor and drain sensor are energized and the gate is operated to keep the controlled water level within predetermined-limits. In case, the gated-control is required to be made automatic for any

requirement other than keeping the water level constant, the switching devices may be provided accordingly. Thus, for emergency closure of the gate of a power channel, in the event of load tripping in a hydro-electric power house, the switching device may be selected responsive to the load tripping so as to energize or de-energize, the inlet sensor and the drain sensor as to control the float drain hoisting mechanism for closing the gate.

2.9 Float Driven Hoisting-Mechanism

2.9.1 Float driven hoisting-mechanism may be considered as the mechanical and functional arrangement through which the force of gravity/bouyancy of the float (hydraulic counterweight or displacer) is processed to operate the gate.

2.9.2 Mechanical Arrangements — It is provided for force/torque transmission such as:

- a) Directly coupled arrangement,
- b) Lever arm arrangement,
- c) Ropes and pulleys arrangement,
- d) Rope drum and line shaft arrangement, and
- e) Chain-sprockets and line shaft arrangement.

Any or a combination of these arrangements may generally be provided keeping in view that it is made as simple as practicable for the given project layout and frictional resistances at the moving surfaces are kept to the minimum.

2.9.3 Functional Arrangements — It is provided to suit the required gate operation by the float-drive such as:

- a) *Gate lifted by weight of float and lowered by bouyancy of float* — It may be termed as arrangement 'A'. In this arrangement, weight of the float serves as hoisting counterweight to lift the gate. When its effect is neutralized by upthrust due to the bouyancy of float under its submergence, the gate lowers under its own weight. The following operating conditions may be considered:

- i) $T_g - T_{bc} = 1.5 T_r$ or more,
- ii) $T_f = (T_g - T_{bc}) + 1.5 T_r$ or more,

where

T_g = Effective torque or tension due to weight of the gate including blast, if any, added to it;

T_{bc} = Effective torque or tension due to the balancing counter-weight;

T_f = Effective torque or tension due to weight of the float; and

T_r = Effective torque or tension due to all the frictional resistances and other forces opposing the gate operation.

In case, $T_{bc} = T_g - 1.5 T_r$, T_f requirement reduces to $3 T_r$ which indicates that reducing the frictional resistances to the minimum, the size of the float may be greatly reduced.

- b) *Gate lowered by weight of float and lifted by bouyancy of float* — It may be termed as arrangement 'B'. In this arrangement, a separate hoisting-counterweight is provided to lift the gate and weight of float is applied to lift the hoisting-counterweight. Thus float moving down lifts the hoisting-counterweight and gate moves down under its own weight. When the effect of float-weight is neutralized by upthrust due to the bouyancy of float under its submergence, the float moves up, the hoisting counterweight moves down and the gate is lifted up. The following operating conditions may, therefore, be considered:

i) $T_g = T_{bc} = 1.5 T_r$

ii) $T_{hc} = (T_g - T_{bc}) + 1.5 T_r$ or more,

iii) $T_f = T_{hc} - (T_g - T_{bc}) + 1.5 T_r$ or more,

where

T_{hc} = Effective torque or tension due to the hoisting-counter-weight.

In case, $T_{hc} = (T_g - T_{bc}) + 1.5 T_r$, requirement of T_f reduces to $3 T_r$ which, as in the case of arrangement 'A' indicates that reducing the frictional resistance to the minimum, the size of the float may be greatly reduced.

2.10 Additional Drive

2.10.1 An additional drive electrically and/or manually operated shall be provided for the hoisting mechanism to operate the gate when the float drive is under maintenance or out of order, or otherwise fails to meet any emergent requirement. Normally, the additional drive may be declutched or be unoperative, so that the gated control is done by the float drive only. However, additional drive or the float drive can be operated independently or in conjunction with each other for controlling the gate movement.

2.10.2 The electric control system of the electric-drive may be provided with a selector switch for manual-control selection or automatic control selection, as required. Generally, where automatic-control is provided for electric-drive as well, the hoisting mechanism with mechanical arrangement of a line-shaft type may be provided with electromagnetic clutch of suitable rating to have automatic-control for clutching and declutching of the electric-drive of the hoisting-mechanism.

2.10.3 The electric control-circuit may be provided as generally provided for a mechanical hoist with electric-drive.

2.10.4 In case no float or static electrodes of submerged type (that is having normally closed switching) are provided, gated control is activated when water level lowers below the electrodes. The chances of gated-control getting wrongly activated by break of control-wiring, may be taken care by suitable design of electric-control-circuit.

2.10.5 Where, simultaneous operation of electric-drive together with float-drive is to be provided, arrangement using ropes and pulleys may be so designed, instead of a line-shaft type requiring electromagnetic-clutch.